UWB Sampler for Wireless Communications and Radar

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Abstract

An ultra wideband (UWB) sampler, realized using step recovery and Schottky diodes on coplanar waveguide, coplanar strips and slotlines, has been developed for UWB wireless communications and radar systems. The impulse generator, providing signal for the sampling gate, was also included along with a new LO feeding structure. The fabricated circuit shows 16-19 dB conversion loss without amplifier and 1-4 dB conversion gain with amplifier across a 9-GHz RF bandwidth with 500-MHz sampling frequency.

1. Introduction

Ultra-wideband (UWB) communications and radar systems, operating up to 10.6 GHz, have received significant attention for various applications such as low interference, high data rate, short-range communications [1] and unexploded ordnance and mine detection [2]. Sampler is one of the most important components in these systems. Especially, low-cost, compact and simple sampling structures are needed for reducing the cost, size and complexity of UWB communications and radar systems. Various microwave integrated circuit (MIC) samplers have been developed, e.g. [3]-[4].

In this paper, we report on the development of a new uniplanar sampler using hybrid MIC for UWB communications and radar systems. The sampler operates over a 9-GHz bandwidth, much wider than that reported in [4] and with a conversion loss of 16-19 dB, much lower than the sampler presented in [3].

2. Circuit Design

Fig. 1 shows an overall layout of the sampler with actual placement of the circuit components, including the impulse generator and LO feeding structure. To reduce possible multiple reflections of the LO pulse in the circuit, good matching must be achieved at the hybrid junction. Location of the sampling diodes is important for minimizing the LO pulse distortion. Since it is impossible to remove the reflection of the pulse completely, there exists a small reflection of the pulse to the diodes. To avoid the resultant distortion effect, the sampling diodes are located a distance L_1 apart from R_T, and L_1 should be the same as L_2.

The bandwidth of the sampler is determined by the gating pulse width applied to the sampling diodes. Therefore, generation of a short-duration pulse is the most important thing for obtaining wide bandwidth.

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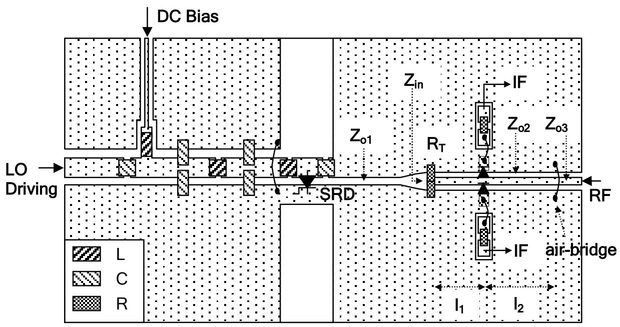

Fig. 1 Sampler layout.

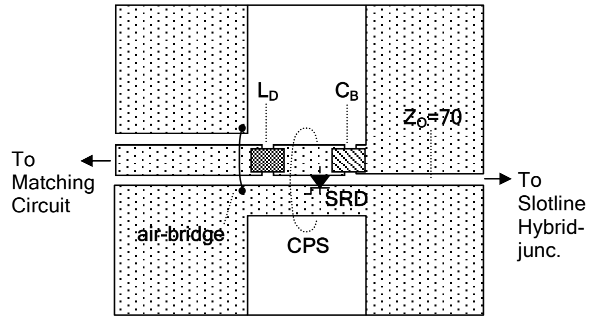

Fig. 2 Pulse generator and LO feeding Structure (central portion of Fig. 1).

The pulse amplitude is also important. A large pulse-amplitude is desirable to improve the conversion efficiency and to achieve high dynamic range. Fig. 2 shows the layout of the impulse generator part and the LO feeding to the diodes via slotline, showing the placement of the SRD and other components.

2. Fabrication and Performance

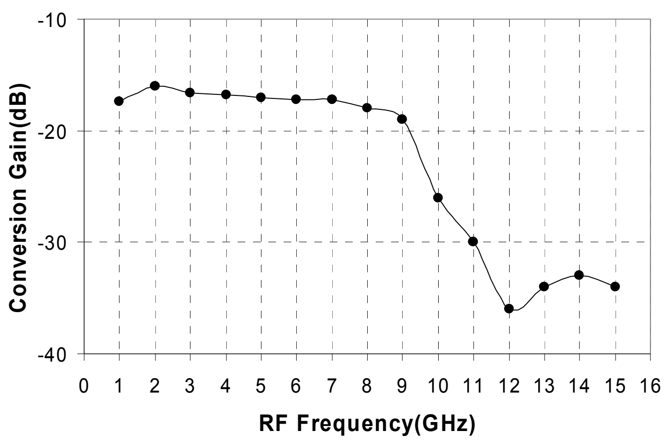

Fig. 3 Measured conversion loss of the sampling circuit without the video amplifier.

The entire sampling circuit, including the pulse generator and IF circuit, is fabricated on a single circuit board of 3 in. × 2 in. using RT/Duroid RO3010 substrate having a relative dielectric constant of 10.2 and a thickness of 0.050 in. The measured return loss at the LO driving port is 30 dB for a driving frequency of 500 MHz. The measured RF return loss is from 7-25 dB over 1-10 GHz. Fig. 3 shows the measured conversion loss of the sampling circuit without the video amplifier. The driving LO power is 12 dBm. As can be seen, for a 3-dB RF bandwidth of 9 GHz, the conversion loss is from 16 to 19 dB. The measured output IF signal is 2 MHz. With an amplifier of about 20-dB gain, the sampling circuit displays a conversion gain from around 1 to 4 dB across the 9-GHz bandwidth. The measured 1-dB compression input power is about 8.5 dBm.

3. Conclusion

A new UWB sampler including impulse generator and IF amplifier has been developed using SRD, Schottky diodes, CPW, CPS and slotlines. The circuit displays a conversion loss from 16 to 19 dB (without amplifier) and a conversion gain from 1 to 4 dB (with amplifier) for a 9-GHz RF bandwidth. The circuit is simple to fabricate and low cost, and is suitable for UWB communications and radar systems.

Acknowledgement

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